Dept. of Computer Science and Engineering, National Sun Yat-sen Univ.
Second Semester of 2018 Ph.D. Qualifying Exam

Operating Systems

1. Round-robin schedulers normally maintain a list of all runnable processes, with each process occurring exactly once in the list. What would happen if a process occurred twice in the list? Can you think of any reason for allowing this? (10%)

2. Five jobs are waiting to be run. Their expected run times are 9, 6, 3, 5, and X. In what order should they be run to minimize average response time? (Your answer will depend on X.) (10%)

3. Solve the dining philosophers problem using monitors instead of semaphores. (10%)

4. Priority inversion is a problem in real-time system and occurs mostly when you use a real-time kernel. Consider a computer with two processes, H, with high priority and L, with low priority. The scheduling rules are such that H is run whenever it is in <u>ready</u> state. At a certain moment, with L in its critical region, H becomes ready to run (e.g., an I/O operation completes). H now begins busy waiting, but since L is never scheduled while H is running, L never gets the chance to leave its critical region, so H loops forever. This situation is sometimes referred to as the priority inversion problem. Please design a scheme to avoid this problem. (20%)

5. Implement counting semaphores (i.e., semaphores that can hold an arbitrary value) using only binary semaphores and ordinary machine instructions (e.g., addition, subtraction, assignment, etc.). (You must show the implementations of operations of *up* and *down* of the counting semaphore. (20%)

6. What is *memory-mapped I/O* and *asynchronous I/O*? (5%)

7. What is the difference between a hard link and a symbolic link? Give an advantage of each one. (5%)

8. Synchronization within monitors uses condition variables and two special operations, WAIT and SIGNAL. A more general form of synchronization would be to have a single primitive, <u>WAITUNTIL</u>, that had an arbitrary Boolean predicate as a parameter. Thus, one could say, for example,
    <u>WAITUNTIL</u> x < 0 **or** y+z < n
    The SIGNAL primitive would no longer be needed. This scheme is clearly more general, but it is not used. Why not? (10%)

9. If an instruction takes 1 <u>nsec</u> and a page fault takes an additional n <u>nsec</u>, give a formula for the effective instruction time if page faults occur every k instruction. Explain your answer. (5%)

10. Suppose that a 32-bit virtual address is broken up into four fields, a, b, c, and d. The first three are used for a three-level page table system. The 4th field, d, is the offset. Does the number of pages depend on the size of all four fields? If not, which ones matter and which ones do not? Explain your answer. (5%)